River valleys of the Eemian Interglacial in central Poland

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The presented fluvial pattern of the Eemian Interglacial in central Poland is the most complete and based on a critical review of the published and archival data. In the final image, the most significant was a relation of this fluvial pattern to a water level of the Eemian sea in the lower Vistula region. Fluvial sediments of the Eemian Interglacial are also present in the tributary valleys, i.e. the Wieprz, Pilica and Narow rivers. A fluvial pattern of the Eemian Interglacial in central Poland is roughly reflected by the present one, with its main northern watershed in the southwestern Mazury Lakeland. Similar fluvial patterns have developed during successive interglacials in the Polish Lowland and therefore, central Poland has acted as a river junction.

INTRODUCTION

Fluvial pattern of the Eemian Interglacial in central Poland is presented. Occasional information on sediments of this age can be found in regional monographs and short communications. A little more data on fluvial sediments of the Eemian Interglacial in central Poland have been supplied by geological mapping during the last 30 years. Many years mapping in the Polish Geological Institute supplied with numerous geologic data, which have been used occasionally only to palaeogeographic reconstruction. These data indicate undoubtedly that a central part of Poland (and particularly, the Warsaw Basin) acted as a main hydrographic junction of the Central European Lowland, but conclusions drawn by different authors were fragmentary and many a time, also contradictory to one another.

Central Poland has not been occupied by an ice sheet since the Wartanian Glaciation but only subjected to successive episodes of fluvial erosion and accumulation. At present many main rivers of the Polish Lowland pass across this very area. However, a fluvial pattern of the Eemian Interglacial could not have been reconstructed in detail yet.

METHOD

Analysed were results of lithologic examination of cores of the research boreholes in central Poland, as well as published sheets (together with attached geologic sections) of the Detailed Geologic Map of Poland in scale of 1:50 000. Geologic sections of research boreholes for these sheets were analysed, to distinguish the Pleistocene buried fluvial series of different age and to describe their lithologic properties. Supplemented with other published information on ancient fluvial series, all these data could be put together and critically revised. This analysis enabled reconstruction of a fluvial pattern of the main river valleys of the Eemian Interglacial in central Poland. Unfortunately, a considerable part of the examined area has not been covered yet with sheets of the Detailed Geologic Map of Poland, on the other hand some sheets have been finished many years ago, which means that they are distinctly out-of-date and present a surficial geologic structure only. The resulting cartographic image of a palaeovalley system of the Eemian Interglacial is considerably varied if its geologic evidence is concerned, and it is still incomplete in many places. The latter is particularly true for

Key words: central Poland, Eemian Interglacial, palaeovalleys, rivers.
Generally the Pleistocene fluvial sediments are not outcropping at the land surface in central Poland and can be analysed in the borehole sections only. Among them, research boreholes for the Detailed Geologic Map of Poland in scale of 1:50 000 created foundations for a correct spatial correlation of the buried fluvial sediments.

Standard lithologic analyses of cores of the test-cartographic boreholes comprise grain size composition, heavy mineral content, simplified petrography of gravels in fraction 5–10 mm (collected mostly from tills), carbonate content and roundness of quartz grains. For determination of fluvial origin the most important are commonly: roundness of quartz grains, heavy mineral content and grain size composition. A simplified petrographic analysis of gravels can be applied occasionally to a rough dating of the analysed fluvial series (cf. K. Kenig, 1998). The authors renewed examination of the original archival material for the Detailed Geologic Map of Poland indicated that the most promising results are to be received from a selective analysis of heavy mineral content and to a smaller degree, from grain size composition (cf. L. Marks, K. Pochocka, 1998a). On the other hand, a principal role ascribed commonly to roundness of quartz grains does not seem reasonable. Good roundness may result from a considerable admixture of the Tertiary material, therefore it does not play a decisive role in determination of the origin of the examined sediment.

EEMIAN RIVER VALLEYS

Critical review of the previously published data, maps included (derived firstly from the Detailed Geologic Map of Poland, scale 1:50 000), enabled to create quite a compact image of a fluvial network of the Eemian Interglacial in central Poland (L. Marks, K. Pochocka, 1998a–c). Its reliability was verified by connecting this ancient fluvial pattern with sediments of the Eemian sea in the Lower Vistula Valley (cf. A. Makowska, 1979, 1984, 1986). Stratigraphic location of the latter was determined by A. Makowska (1979), who found a gradual transition from marine sediments in the north, through deltaic sediments to typical fluvial series in the south. Much helpful was the evidence that a water level of the Eemian sea was very close to the present water level in the Baltic Sea (L. Marks, K. Pochocka, 1998a–c; see also K. L. Knudsen, 1985; B. Koseck, W. Lange, 1985; B. Menke, 1985; G. Steinich, 1992; J. E. Mojski, 1993).

The presented fluvial network of the Eemian Interglacial seems to be the most complete and critically revised collection among the available information. It is reliably related to the assumed water level of the Eemian sea in the Lower Vistula region. Fluvial sediments of the Eemian Interglacial were found mostly close to and within the present Vistula valley, but they have been occasionally dated only. They fill an ancient river valley, about 10 km wide (Fig. 1), wider in vast basins at mouths of the larger tributaries, e.g. the Pilica River (to 15 km wide) and the Narew River (even to 25 km). In the northern part of the Sandomierz Basin in southern Poland, a base level of erosion of the Vistula from the Eemian Interglacial occurs at about 120 m a.s.l. In the Vistula gap of the South Polish Uplands (between a mouth of the Kamienna River and Pulawy), a base of a fluvial erosion during the Eemian Interglacial depended mostly on lithology of the bedrock (Fig. 2). Where the latter is composed of the Upper Cretaceous gazines and limestones, the palaeovalley is relatively narrow (from 1 km near Kazimierz Dolny to 2.5 km near Opole Lubelskie), and incised to about 120 m near Zawichost and 115 m a.s.l. (i.e. 5 m below a bed of the Holocene fluvial series) at mouth of the Kamienna River (W. Pozaryski et al., 1994a, b). Further downstream it drops to 112 m near Opole Lubelskie (W. D. Dowgiełło, 1991), 110 m at Janowiec (W. D. Dowgiełło, 1982) and 105 m a.s.l. at Pulawy (Fig. 2). No convincing evidence for neotectonic movements are provided, except for the Pulawy region where the Tertiary dislocations have been presumably rejuvenated during the Quaternary. Lithology of the bedrock changes downstream: the more easily eroded Palaeocene gazines and sands with admixture of phosphorite concretions occur in the reach Pulawy–Deblin, and downstream there are the Oligocene and Miocene sands. Therefore, the river bed of the Eemian Interglacial drops down to 85 m at Deblin (M. Zarski, 1991), and...
80 m a.s.l. at Kozienice (M. Żarski, 1996a, b; however, after A. Makowska, 1969, it is assumed to occur at about 88 m a.s.l. there), and the paleovalley gets considerably wider (Fig. 1).

In the vicinity of Kozienice, sediments of the Eemian Vistula were thermoluminescence dated at 93±13 ka BP (M. Żarski, 1996a, b).

This gradual lowering of the bed of fluvial sediments of the Eemian Interglacial is disturbed near Magnuszew where it rises to 84 m a.s.l., and they are located within a fluvial series of the Mazovian (Holsteinian) Interglacial (Z. Sarnacka, 1979). Such a high location of the bed of fluvial sediments of this interglacial does not seem reasonable. It can be exclusively due to incorrect chronologic determination of the sediments. To the north from a mouth of the Pilica River, the Eemian alluvia are underlain by fluvial sands of the Mazovian (Holsteinian) Interglacial but occasionally, they also contact directly with the Pliocene clays (especially in Warsaw and to the south of it), among others near Góra Kalwaria where river erosion reached to about 70 m a.s.l. (Z. Sarnacka, 1966, 1968), i.e. 20 m below the present water level of the Vistula (Fig. 2).

Fluvial sediments of the Eemian Interglacial are also present in the tributary valleys, e.g. of the Wieprz and Pilica rivers. In Warsaw, the buried fluvial sediments of the Eemian Interglacial occur at 72–65 m a.s.l. (W. Morawski, 1979; Z. Sarnacka, 1980). The river reached locally the glaciotectonically deformed Pliocene sediments, i.e. its bed is located at 58–62 m a.s.l. Fluvial sediments are 25 m thick and form 3 sedimentary cycles. Sometimes a bed of fluvial sediments of the Eemian Interglacial has been determined wrongly as too low in the Warsaw area, i.e. at 40–45 m a.s.l. (J. Nowak, 1977, 1978; Z. Sarnacka, 1992; W. Słowański et al., 1995). Downstream from Warsaw the pre-Narew River or most probably, the pre-Bug River joined the main river from the east (Fig. 1). In the north-central Poland, a bed of the Eemian fluvial sediments occurs at 60–54 m a.s.l. and a course of the Eemian river valley is generally reflected by the present one. General coincidence of the present and the Eemian fluvial network in central Poland is disturbed downstream (cf. A. Makowska, H. Ruszczyńska, 1960). In the Plock Basin where no Eemian sediments of the pre-Vistula are noted — directly beneath fluvial series formed during the last glaciation (series of the ice-marginal spillway), there are older tills of the South Polish Glaciations (Elsterian). The Eemian fluvial sediments appear, however, again near Dobrzyń and Włocławek in the Toruń Basin, with their bed at about 50–58 m a.s.l. (J. E. Mojski, 1961; S. Skompski, 1972). On the other hand, J. W. Jeziorski (1991) determines a bed of fluvial sediments of the Eemian Interglacial near Cięchocinek at about 30 m a.s.l., what seems really reasonable.

In the valley of the lower Bug River, a bed of fluvial sediments of the Eemian Interglacial occurs at 70 m a.s.l. at Ostrów Mazowiecka (R. Żuk, 1993) and Małkinia Góra (K. Wrotek, 1995). In the Bug River valley near Treblinka, alluvia of the Eemian Interglacial were thermoluminescence dated at 83±12 ka BP (K. Wrotek, 1995). Further westwards, a bed of fluvial sediments of the Eemian Interglacial drops to 60 m at Wyszków (K. Straszewska, 1968) and about 50 m a.s.l. at outlet of the Bug River into the Narew River (Fig. 3). Then it rises to 60 m at the outlet of the Narew River into the Vistula near Zakroczym, and drops again to 54 m a.s.l. near Wyszo-
gród. Such overdeepening in the interfluve of the Vistula and the Narew at Legionowo corresponds exactly to a distinct depression (glacial tunnel valley) in the Quaternary bedrock and seems to result from varied post-depositional compaction of the sediments (Fig. 3).

CONCLUSIONS

The presented fluvial network of the Eemian Interglacial in central Poland is the most complete and a critical review, both of the published and the archival data. Similar fluvial patterns have developed during successive interglacials in the Polish Lowland; thus, mid-central Poland acted as a junction of a fluvial system during the Quaternary. In the final image, the most significant was a relation of this fluvial pattern to the probable level of the Eemian sea in the Lower Vistula region. In central Poland a fluvial pattern of the Eemian Interglacial is roughly reflected by the present one (cf. I. Pawłowska, 1996), and the main northern watershed ran in the southwestern Mazury Lakeland (L. Marks, 1988). Fluvial sediments of the Eemian Interglacial are also present in the tributary valleys to the Vistula, e.g. valleys of the Wieprz, Pilica and Narew rivers. This pattern resembles therefore a fluvio-periglacial drainage system, developed at the end of the Wartanian Glaciation. During the Vistulian Glaciation, it was considerably transformed due to widespread ice-dam deposition, when the ice sheet which advanced into the Plock Basin, made a northwestward runoff impossible and a vast ice-dam lake developed in the Warsaw Basin. The latter resulted in a rise of the base of erosion in the middle Vistula Basin and partly also in the upstream part of this river. The valley of the middle Vistula was filled with widespread ice-dam deposition and then considerably incised, due to development of a vast ice-marginal spillway during the Vistulian Glaciation. Only sediments of the youngest Pleistocene river runoff are present at a land surface in the Vistula valley and its tributaries. They form overbank terraces which correspond to water outflow in ice-marginal spillways that developed in ice sheet forefield during the Vistulian Glaciation.

The presented spatial image of the buried river valleys of the Eemian Interglacial is not in fact a simultaneous one and has never existed as such (Fig. 1). It presents, however, a complex image of a fluvial discharge, changing during the Eemian Interglacial, and possible misunderstandings result mainly from a lack of credible dating methods.

REFERENCES


SIEŚ RZECZNA INTERGLACJALU EEMSKIEGO W POLSCE ŚRODKOWEJ

Strzegome

Celem badań było kartograficzne przedstawienie systemów dolin rzecznych aktualizowanych w interglacjale eemskim na obszarze Polski środkowej. System ten odgrywał w czwartorzędnym dziedzinie rolę wodno-hydrograficzną. Przez ten rejony przepływały główne rzeki Polski, w tym Wisła, na której upływają wody podziemne. W badaniach zastosowano metody kartograficzne oraz interpretację obrazu hydrograficznego. Ostateczne weryfikacje przedstawionych obrazów zapewniły podstawy dla dalszych badań w obszarach geologicznych.

Doliny rzeczne w interglacjale eemskim występowały w Polsce środkowej w przybliżeniu podobnie do współczesnego. System ten odgrywał w czwartorzędnym dziedzinie rolę wodno-hydrograficzną. Przez ten rejony przepływały główne rzeki Polski, w tym Wisła, na której upływają wody podziemne. W badaniach zastosowano metody kartograficzne oraz interpretację obrazu hydrograficznego. Ostateczne weryfikacje przedstawionych obrazów zapewniły podstawy dla dalszych badań w obszarach geologicznych.

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wanych oraz archiwalnych i ma charakter zbiorczy. Oznacza to, że sieć rzeczna została uznana za równowartkową, chociaż faktycznie nigdy nie istniała w takim ujęciu. Jest to natomiast syntezą przepływu rzeczniczego zmieniającego się w czasie interglacjaliu, zaś istniejące niejasności wynikają z braku wiarygodnych metod datowania osadów rzecznych.

W analizowanym obszarze Polski środkowej nie stwierdzono dotychczas przekonywających dowodów na intensywne ruchy neotektoniczne. Jedynym wyjątkiem jest rejon Puław, gdzie uskoki trzeciorzędowe zostały najprawdopodobniej odnowione w czwartorzędzie.